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May 1999

Director's Report to the 50th Tuna Conference

On Tuna and
Tuna-Related Activities at the
Southwest Fisheries Science Center
for the Period May 1, 1998
to April 30, 1999

Administrative Report
LJ-99-05

National Marine Fisheries Service
Southwest Fisheries Science Center
P.O. Box 271
La Jolla, CA 92038

This annual report describes tuna-related research at the Southwest Fisheries Science Center during the period May 1998 through April 1999. The work was conducted by the La Jolla Laboratory in California and the Honolulu Laboratory in Hawaii.

The primary focus of the Center's research during the year was on providing quality scientific information in support of the regional fishery management councils, international working groups and committees, and the National Marine Fisheries Service's Southwest Region and headquarters. The research included stock assessments and basic biological research for analyzing management alternatives, especially for limited-entry regimes; biological and technological research to eliminate or minimize interactions between fisheries and protected species; and mathematical modeling to improve understanding of fishery interactions and fish movements and to help predict some of the consequences of management actions.

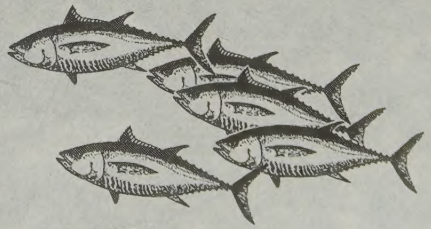
In addition, marine mammal researchers at the La Jolla Laboratory were largely occupied with preparing for and conducting a dolphin abundance survey in the eastern tropical Pacific Ocean and preparing a Congressional report on the results of the survey and dolphin stress studies. Center scientists also were active in international forums concerning tuna issues, including the Interim Scientific Committee for Tuna and Tuna-like Species in the North Pacific, the Standing Committee on Tunas and Billfish, the Multilateral High Level Conference, and the Indian Ocean Tuna Commission. Center staff also contributed status of stocks reports on large pelagic fishes and fishery-associated marine mammals for the upcoming national report *Our Living Oceans 1999*.

During the year the Center celebrated the 50th anniversary of the Honolulu Laboratory and its many significant contributions to tuna research and marine science. This year the Tuna Conference also is celebrating its 50th anniversary. I am proud that this Center played a significant role in keeping the conference alive as well as in transforming it into the preeminent international forum for the discussion of developments in tuna and large pelagics research and fisheries. I wish the conference well as it continues into the new millennium.

Michael F. Tillman, Ph.D.

Science Director, Southwest Region

May 1999
La Jolla, California



This Administrative Report is issued as an informal document to ensure prompt dissemination of preliminary results, interim reports, and special studies. We recommend that it not be abstracted or cited.

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I. CENTRAL AND WESTERN PACIFIC TUNA FISHERIES

U.S. Tuna Fishery Annual Report – The status of the U.S. tuna purse seine fisheries of the central and western Pacific Ocean was monitored throughout the year by the Southwest Regional Office (SWR) and the Southwest Fisheries Science Center (SWFSC). At the annual meeting of the South Pacific Regional Tuna Treaty in March 1999, Senior Scientist Gary Sakagawa presented a working paper (Coan et al., 1999) titled "The 1998 U.S. tropical tuna purse seine fishery in the central-western Pacific Ocean," which reviewed data collected from the fishery and the current status of skipjack, yellowfin, and bigeye tuna stocks in the area. Highlights of the paper are given below.

Thirty-nine U.S. purse seiners made total landings of 176,763 metric tons (t) of tuna from the central and western Pacific in 1998, compared to 144,082 t in 1997. Skipjack tuna dominated landings at 135,000 t, with lesser quantities of yellowfin tuna (36,200 t) and bigeye tuna (5,500 t). The overall catch rate (27.3 t per day fished) was the highest level since 1994. The catch rate for skipjack tuna (21.5 t per day fished) was up 78% from 1997, while the yellowfin tuna catch rate was down 31%. Fifty-five percent of the U.S. fleet's fishing effort was expended on schools of tuna associated with fish aggregation devices (FADs) or "logs" (floating objects) and the remainder on free-swimming schools of tuna.

Sampling of the U.S. fleet's catch continued in 1998. Logbooks and landings data were collected from 100% of the fleet. At U.S. canneries in American Samoa, length measurements were taken of approximately 48,800 fish and species composition samples were taken from 20,000 fish to obtain the catches by species. Samples indicated that skipjack tuna ranged in size from 31 to 80 cm fork length (FL), with an average size of 49 cm FL. The average size of skipjack tuna caught in free-swimming schools (54 cm FL) was slightly larger than in log sets (48 cm FL). Yellowfin tuna ranged in size from 31 to 146 cm FL, with an average size of 70 cm FL. Yellowfin tuna caught in free-swimming schools were significantly larger (116 cm FL on average) than yellowfin tuna in log sets (56 cm FL). Bigeye tuna ranged in size from 36 to 114 cm FL, and the average size (54 cm FL) was the same in both log and school sets.

Overall, the tropical tuna stocks of the central and western Pacific appear to be in good health. Possible overfishing of bigeye tuna stocks is of some concern, however, as previous studies have shown that catch rates of longliners, which catch mainly large bigeye tuna, have been decreasing, while catches of small bigeye tuna by purse seine fleets have been increasing.

American Samoa Longline Fishery – The American Samoa domestic longline fishery has developed rapidly over the past 4 years. Most vessels in this fishery are small, 20- to 30- foot *alia* (open steel-hulled catamarans) setting 100 to 300 hooks hauled by hand cranks on one-day trips. Twenty-six longliners were active in 1998, taking 1,756 trips (and sets). Approximately 770,000 hooks were set. Most fishing occurs within 25 miles of shore. The primary catch is albacore (20,071 fish caught) with a catch rate of 26.15 per 1,000 hooks. Skipjack tuna is the second catch (2.66 per 1,000 hooks) and yellowfin tuna is third (1.81 per 1,000 hooks). All other fish are relatively incidental.

U.S. Fishery Information Presented at SCTB Meeting – The 11th meeting of the Standing Committee on Tunas and Billfish (SCTB) was held in Honolulu May 30–June 6, 1998. The purpose of the international meeting was to review the status of the tropical tuna and billfish stocks in the central

and western Pacific. At the meeting, staff of the La Jolla Laboratory's Pelagic Fisheries Research Division (PFRD) presented three papers. The first paper, "U.S. fisheries for tropical tunas and billfish of the central-western Pacific and South Pacific albacore, 1993-1997," presented statistics on catch, fishing effort, and size-frequency of the catches for the U.S. purse seine, longline, troll, and pole-and-line fleets. The second, "Standardization of yellowfin tuna CPUE for U.S. purse seiners fishing in the central-western Pacific," analyzed yellowfin tuna catch per unit of effort (CPUE) for U.S. purse seiners with a generalized linear model and found no significant trend during the period 1988–1997. The third paper, "An observation on CPUE for U.S. and Japanese purse seiners fishing in the central-western Pacific," showed how the recent switch from fishing on school fish to fishing on drifting objects has affected CPUE for these two major fisheries.

New Senior Scientist for Highly Migratory Species – PFRD Director Gary Sakagawa has been named the Center's senior scientist for highly migratory species. In his new capacity, Dr. Sakagawa will be involved in high-level international negotiations on management of Pacific stocks, development of U.S. policies, leadership in international scientific efforts, and strategic planning for research in support of U.S. highly migratory fisheries. Dr. Norm Bartoo has been named acting director of the PFRD.

Research Group Report Published – The SWFSC supervised the production and publication of the Report of the Seventh Annual Meeting of the Western Pacific Yellowfin Tuna Research Group during the past year. This report of the group's 1997 meeting in Fiji provides new information on western Pacific tuna stocks and includes a section devoted to recent developments in the tropical tuna fisheries with comprehensive catch statistics for yellowfin tuna, skipjack tuna, and bigeye tuna for the period 1970 through 1996. Copies of the report are available from the PFRD in La Jolla.

II. INDIAN OCEAN TUNA FISHERIES

1998 Indian Ocean Fishery Data – Data on the tuna purse seine fishery in the western Indian Ocean have been received from the Seychelles Fishing Authority and updated through June 1998. The data are summarized in computer spreadsheets and cover the period 1983 to the present. Estimates of catch for the most recent semester may be revised upward when logbooks are eventually received for fishing trips completed too late for inclusion in this data set.

According to returned logbooks, an average of 50 licensed vessels participated monthly in the purse seine fishery in the western Indian Ocean during the first semester of 1998 (18 Spain; 15 France; 5 Seychelles; 4 Belize; 3 Netherland Antilles; 3 Panama; 1 Italy; and 1 Mauritius). This compares to 51 vessels recorded for the same period in 1997 (Table 1). The number of vessel days fished was 7,393, down 1% from the previous year.

Purse seine catches of skipjack tuna, yellowfin tuna, and other tunas (mainly bigeye and albacore) in the western Indian Ocean in the first semester of 1998 totaled 128,368 metric tons (t), up 5% from the previous year (Fig. 1). The species breakdown was 64% skipjack tuna, 25% yellowfin tuna, and 11% other tunas.

The catch rate for all tuna species was 17.4 t per vessel-day, up from 16.3 t the previous year. Catch rates for skipjack and yellowfin tunas were 11.1 t and 4.4 t per vessel-day, respectively (Fig. 2).

Expert Consultation Held – The Seventh Expert Consultation on Indian Ocean Tunas convened in Victoria, Seychelles, November 9–14, 1998. Senior Scientist Gary Sakagawa

participated in the consultation and also convened a session on tuna biology. During the consultation, participants reviewed the status of Indian Ocean tuna and billfish stocks and discussed issues related to the fisheries. Several key findings and advice resulted from discussions on fishery data collection, sampling, and monitoring, and ways to increase participation by Taiwan experts in Indian Ocean Tuna Commission activities.

IOTC Meeting Highlights – The Third Session of the Indian Ocean Tuna Commission (IOTC) was held December 9–12, 1998, in Mahe, Seychelles. Among the issues discussed were the status of Indian Ocean tuna and billfish stocks, reorganization of IOTC fishery databases, data collection and statistics, data confidentiality, fishing capacity, and the election of officers and other organizational issues. The commission agreed to establish working groups on data collection and statistics, tunas, and billfish. The commission also agreed "to pursue an appropriate arrangement to deal with the issue of the implications of catches by Taiwan Province of China on the scientific assessment of tuna stocks." Assessments for some stocks rely heavily on Taiwanese fisheries data, yet Taiwan experts cannot participate in IOTC activities as part of the Republic of China delegation. The next session of the IOTC will be hosted by the Japanese delegation in December 1999.

III. PACIFIC ALBACORE FISHERIES

Albacore Fishery Data Summarized – Statistics on the 1997 U.S. North and South Pacific albacore troll fisheries were analyzed during the year and published in a report (Childers and Miller, 1998) distributed to the public. The report summarizes logbook data collected from cooperating fishermen and length-frequency data obtained through port sampling from U.S. troll and baitboat vessels operating in the Pacific Ocean.

North Pacific Fisheries – The U.S. catch of North Pacific albacore was 14,900 t in 1997, a slight decrease from the 15,600 t caught in 1996. The CPUE (number of fish per day fished) in the North Pacific decreased significantly to 46 fish per day in 1997 from 91 fish per day in 1996. This decrease is probably related to the large influx of new and inexperienced fishermen who entered the fishery because of reduced fishing opportunities in other West Coast fisheries. The average size of fish in the North Pacific catch increased to 70 cm (15 lb or 7.0 kg) in 1997 from 66 cm in 1996.

South Pacific Fisheries – In the South Pacific, the U.S. catch of albacore decreased to 1,400 t in 1997 from 2,200 t in 1996. Total fishing effort by U.S. vessels during the 1996-97 season was 2,885 days, a 37% decrease from the previous season. The CPUE in the South Pacific increased slightly to 79 fish per day in 1997 from 71 fish per day in 1996. Average size of fish in the South Pacific catch was 67 cm (14 lb or 6.2 kg) in 1997, compared to 69 cm in 1996.

American Fishermen's Research Foundation Activities – Acting PFRD Director Norm Bartoo participated in the November 1998, January 1999, and April 1999 meetings of the board of directors of the American Fishermen's Research Foundation, to review proposed research on North and South Pacific albacore stocks and provide technical advice on upcoming projects. The foundation's 1999 North Pacific research program includes data collection and analysis on ocean water column stability and the effects on albacore availability, funding of a postdoctoral student to examine albacore stock structure and migration using satellite pop-up archive tags, and continuation of a cooperative albacore logbook program with the SWFSC to collect catch and effort data from the fishery. No research is slated in conjunction with the South Pacific albacore fishery this year.

Albacore Workshop Report Published – The Report of the Fifteenth North Pacific Albacore Workshop (Shaw and Bartoo, 1998) is available from the Canadian Department of Fisheries and Oceans. The 38-page report includes a review of North Pacific albacore fisheries and statistics, biological and ecological analyses, status of the albacore population, and recommendations from the workshop.

IV. HAWAII LARGE PELAGIC FISHERIES

Developments in the Hawaii Longline Fishery – The Hawaii-based domestic longline fishery had a record year in terms of pounds landed (whole weight). Landings were 27.1 million pounds ($57.9 million ex-vessel revenue). The total number of longline fishing vessels (115) was higher in 1998 compared to recent years but remains approximately 20% below the peak years of the early 1990s (Table 2). The largest change has been the shift in targeting from swordfish to tuna, with only 32 vessels taking swordfish-directed trips in 1998 (Table 2). Only 7.5% of the trips targeted swordfish in 1998. As in recent years, some longline vessels targeting swordfish off-loaded and operated out of ports in California for at least part of the year. Information on these trips is being obtained through cooperation with the State of California but is not yet compiled to be available for this report.

Most longline fishing trips were conducted outside the Exclusive Economic Zone (EEZ), but 50% of the trips made sets within the main Hawaiian Islands EEZ (28% of total sets were made within the main Hawaiian Islands).[1] There was also a substantial increase in the number of trips to the U.S. possession islands (Johnston Atoll, Palmyra Atoll, and Kingman Reef in particular).

[1]Trips can make sets in multiple areas.

Bigeye tuna and blue shark were the leading catch: 60% of sharks caught were retained, primarily as a finned product. Bigeye landings were 5.4 million pounds (valued at $25 million); albacore landings were 2.4 million pounds ($3.1 million), down substantially from 1997. Yellowfin tuna landings, which tend to follow a biennial cycle, were down in 1998 (1.8 million pounds). Economic forces had an impact in 1998 of encouraging landings of bigeye tuna for the sashimi market while discouraging landings of albacore for canneries. Shark landings were valued at $1.6 million.

The bigeye tuna catch rate on tuna targeted trips was 6.13 per 1,000 hooks. Albacore, which had shown a marked rise since the early 1990s, had a lower CPUE (1.96 per 1,000 hooks) on mixed target trips and (bigeye) tuna targeted trips (3.02 per 1,000 hooks) in 1998 compared to 1997.

Longline catch is summarized in Table 3, average round weight per fish is shown in Table 4, while revenue is summarized in Table 5.

Interactions by the longline fishery with protected species (turtles and seabirds) continues to be an important issue, as is the finning of sharks. Honolulu Laboratory scientists have been working on a range of studies on each of these issues.

Archival Tagging Project – Information on migration patterns and how environmental factors influence distribution and catchability is needed to understand harvest impacts and interactions among fisheries for tuna and billfish across the Pacific. Archival tags, a new tool for studying fish movement and habitat over long periods, have produced important insights into long-term cyclical movement patterns that decades of conventional tagging and ultrasonic tracking research have not. The Honolulu Laboratory is conducting an archival tagging project on

bigeye tuna and swordfish in collaboration with the Joint Institute for Marine and Atmospheric Research's Pelagic Fisheries Research Program (JIMAR PFRP, University of Hawaii) and the Commonwealth Scientific and Industrial Research Organization (CSIRO) of Australia.

In April 1998, 24 fully tested tags were deployed on adult bigeye tuna (76-133 cm FL) during a longline research cruise aboard the NOAA ship *Townsend Cromwell* near the island of Hawaii. During January 1999 a second cruise successfully deployed an additional 26 archival tags, again on bigeye tuna. In the latter cruise both adult (96-122 cm FL) and juvenile (54-66 cm FL) fish were equipped with archival tags. The former had tags placed intramuscularly, and in the latter, tags were placed into the peritoneal cavity.

More important, in early July 1998, a bigeye tuna carrying an archival tag was recaptured near the island of Hawaii. The fish had been at liberty for approximately 3 months before recapture. Preliminary calculations of position showed that the fish remained within a few hundred miles of the leeward coast of the island of Hawaii. As observed during studies of bigeye tuna carrying ultrasonic transmitters, the fish spent daylight hours at depth and returned to the surface at night. Surprisingly, however, the fish was found to descend much deeper (up to 500 m) and into much colder water (down to approximately 5°C) than bigeye tuna were previously thought to do. During daylight the fish made regular upward excursions into the warm surface layer in order to maintain body temperature, which never went below approximately 17°C.

The minimum depths reached during the night were also found to be strongly correlated with moon phase: the fish would ascend to shallower depths during the new moon. These observations confirmed and explain the demonstrated correlation between catch rate of bigeye tuna on longline gear and moon phase.

Another simulation examined the effect of a 50% pulse in primary productivity. Fast-growing, short-lived animals such as mahimahi, squids, flying fish, small billfishes, and small tuna respond quickly to the increased productivity, increasing in biomass by 50% within a year after the productivity pulse. For these animals the biomass increase is short lived (1-4 years), whereas large tunas and juvenile sharks showed more moderate biomass increases (5% to 15%) that were sustained for longer periods. Adult billfishes and sharks showed very little response to the pulse.

Habitat and Physiological Ecology of Yellowfin Tuna – The physiological capabilities of tuna that determine their habitat and capture depth are the subject of a JIMAR PFRP-sponsored project in collaboration with the Honolulu Laboratory. Studies of habitat depth have important influences on catchability and have played an important role in improving stock assessment models.

As part of this project, a paper will appear in a forthcoming issue of *Marine Biology* titled "Horizontal movements and depth distribution of large adult yellowfin tuna (*Thunnus albacares*) near the Hawaiian Islands recorded using ultrasonic telemetry, with implications for their physiological ecology." The study measured the horizontal and vertical movements of 5 adult yellowfin tuna (estimated body mass 64-93 kg), while simultaneously gathering data on oceanographic conditions and currents. Fish movements were recorded by means of ultrasonic depth-sensitive transmitters. Depth-temperature and depth-oxygen profiles were measured with vertical conductivity-temperature-depth casts, and the current velocity field was surveyed using an acoustic Doppler current profiler.

Large adult yellowfin tuna were found to spend approximately 60% to 80% of their time in or immediately below the relatively uniform temperature surface layer (i.e., above 100 m), a behavior pattern similar to that previously reported for juvenile yellowfin tuna, blue marlin, and striped marlin tracked in the same area. In all 3 species, maximum swimming depths appeared limited by water temperatures 8°C colder than surface layer water temperature. Therefore, neither large body mass nor the ability to maintain elevated swimming muscle temperatures due to the presence of vascular counter-current heat exchangers in tunas appears to permit greater vertical mobility, or the ability to remain for extended periods below the thermocline.

In those areas where the decrease in oxygen with depth is not limiting, the vertical movements of yellowfin tuna, blue marlin, and striped marlin all appear to be restricted by the effects of water temperature on cardiac muscle function. Like juvenile yellowfin tuna, but unlike blue marlin and striped marlin, adult yellowfin tuna remained within 18.5 km of the coast and became associated with floating objects, including anchored FADs and the tracking vessel. Like juvenile yellowfin tuna, large adult yellowfin tuna repeatedly revisited the same FAD and appeared able to navigate precisely between FADs that are up to 18 km apart. The median speed over ground ranged from 72 to 154 cm s^{-1}. Neither speed nor direction was found to be strongly influenced by currents.

Research Study to Reduce Longline Fishing Gear-Seabird Interactions – In addition to the archival tag deployments during April 1998, a longline research cruise to test the effectiveness of various methods to reduce or eliminate seabird mortality associated with commercial longline fishing operations was completed. NOAA ship *Townsend Cromwell* cruise TC-99-02 tested various deterrents to seabird interactions with longline fishing gear. Swordfish longlines are usually set at night, but occasional daylight setting of these near-surface longlines, and normal daylight hauling, can result in takes of protected seabirds, especially black-footed and Laysan albatrosses. Researchers tested tori lines ("scarecrows"), weighted lines (fast sinking), and camouflaged (blue dyed) bait to deter seabirds from the lines during setting and haulback. No birds were hooked during the cruise, even during trials using large net pins rather than hooks. When birds swallowed these safety hooks, they easily regurgitated them. Albatross routinely regurgitate food to feed their young and to get rid of indigestible material such as squid beaks. Preliminary examination of cruise results indicates that each of the deterrents used substantially reduced bird contacts during longline settings.

Swordfish Length-Weight Interrelations Study Completed – Relationships among commonly used length and weight metrics were described for swordfish from the central North Pacific and will be published soon as a NOAA Technical Memorandum. Relationships were described using swordfish sampled by SWR observers aboard commercial vessels of the Hawaii-based longline fishery during 1994-97 and caught on research cruises of RV *Townsend Cromwell* during 1991-97. The described relationships provided previously unavailable information required for pending stock assessments of Pacific swordfish made necessary by the post-1988 expansion of Hawaii-based swordfish catches. Findings further allowed interconversion of length and weight metrics for comparison with swordfish landings on the U.S. Atlantic seaboard and elsewhere. Sex had a statistically significant but minor effect on weight-at-length. In general for both sexes, weight-at-length averaged nearly 10% greater during December–March and prior to the peak April–June spawning period than during July–September.

Swordfish Size-at-Age Studies Continued – Age and growth studies of swordfish continued with complementary analyses using otoliths and anal fin rays. Counts of presumed daily growth increments (DGIs) have been completed for a cumulative total of 33 young-of-the-year (YOY) and yearling swordfish ranging from 4 to 135 cm eye-to-fork length (EFL) and an estimated 13 to 616 days old. Length at age 365 days has been estimated as 98 cm EFL (95% CI = 93 to 103 cm EFL) based on DGIs; this estimate compares favorably with that at age 1 year based on fin rays (see below).

Preparation and analyses of anal fin rays continued for swordfish spanning the entire range of exploited sizes from about 70 to >230 cm EFL. Preliminary age estimates and fin ray measurements have been completed for a cumulative total of more than 1,300 fish using the light microscope. Cross sections of rays are now being further examined with an image analyzer, and a substudy to characterize within- and between-reader ageing errors has been initiated. A major, ongoing emphasis has been to match size at age 1 year from fin ray cross sections with size at age 365 days from otolith DGIs. Our best current estimate of length at age 1 year based on fin rays is 95 cm EFL (95% CI = 92 to 98 cm EFL). Limited (n = 3) recaptures of tagged yearling fish at liberty for 1, 2, and 4 years indicate that our preliminary characterization of length-at-age is reasonable.

A von Bertalanffy growth function utilizing comprehensive data for YOY through large adult fish would provide more accurate estimates of instantaneous growth rates. However, the standard von Bertalanffy growth equation is unable to accommodate the rapid growth of YOY swordfish, and the use of other, more generalized growth functions is being explored. Estimates of growth as well as age-at-maturity distributions are essential elements of pending age-specific stock assessments for swordfish in the Pacific.

Swordfish Reproductive Studies Continued – Many well-developed swordfish ovaries collected by SWR observers aboard commercial vessels of the Hawaii-based longline fishery during 1994-97 are being examined to characterize size-specific batch fecundities. Together with estimates of spawning frequency based on incidence of postovulatory follicles, batch fecundities might prove useful for estimating egg production in egg-per-recruit analyses.

Morphological/Chemical Proxies of Swordfish Sexual Identity – Using size composition data for known-sex swordfish caught by the Hawaii-based pelagic longline fishery during 1994-97, a strong (r^2 = 0.87) relationship between proportional female and body length (EFL) was described and incorporated in a paper on swordfish maturity, sex ratio, and size composition reported at the 1998 Tuna Conference and recently submitted to *Fishery Bulletin.* A spatially and temporally refined version of this mathematical relationship might be applicable to the Hawaii-based longline fishery; if so, this would allow swordfish landings data to be partitioned by sex based on size composition. Sex-specific catch data are necessary if the power of sex-specific age-at-maturity and growth rate data are to be fully utilized in future age-structured stock assessments.

Results to date of an ongoing attempt to develop a monoclonal antibody (mAB) assay of swordfish vitellogenin (VTG, a protein precursor of egg yolk) have been encouraging. An mAB assay to swordfish egg yolk VTG has been successfully developed by Dr. Nancy Denslow, University of Florida, Gainesville, using the frozen ovaries of a large female swordfish longlined on a NOAA ship *Townsend Cromwell* cruise to the equatorial Pacific in August 1997. The mAB developed has proven capable of recognizing the presence of VTG in (hence

the sex of) muscle tissues of several unrelated fish species; cold storage of tissues for several weeks does not appreciably reduce the sensitivity of the assay. The assay is now being evaluated for its ability to distinguish between the muscle tissues of immature and mature male and female swordfish. Practical application of the assay would likely cost about $15 per fish. If the assay proves capable of consistently identifying the sex of individuals, its greatest value may lie in identifying the sex of large swordfish individuals when tagged, and subsequently aid the interpretation of movements and other activity data that surely differ among different-sized swordfish of the two sexes.

Pelagic Economic Research – The Hawaii Fishing Industry and Vessel Economics (HIFIVE) project of the University of Hawaii's JIMAR PFRP is the primary locus for economic research at the Honolulu Laboratory. A cost-earnings study of the charter boats in Hawaii was completed in 1998 (Hamilton, 1998). A brief study of tuna market dynamics was also initiated in 1998 and will be completed in 1999. A study of charter boat patrons is beginning in 1999 and further analysis of the production dynamics of the longline and small boat sector is proceeding.

Comprehensive Research Program on Pacific Bigeye Tuna – A meeting hosted by the JIMAR PFRP was convened November 9–11, 1998. The purpose of this meeting was to develop a prospectus for a coordinated international research plan to address scientific uncertainties regarding bigeye tuna populations in the Pacific Ocean. This resource is conservatively estimated to be worth in excess of $1 billion annually. The meeting, held in Honolulu, was attended by scientists and managers from institutions and countries spanning the Pacific basin.

Following introductory remarks which provided background on the importance of bigeye tuna and the requirements for improved information for fishery managers, representatives from each of the major fishing regions discussed current and proposed regional research efforts. Following regional issues, the focus shifted to detailed discussions about research methodologies. Topics included regional and basin-scale efforts to examine movement, behavior, and physiology of bigeye tunas and monitoring of their habitat using a combination of advanced electronic archival tags, conventional tags, acoustic tracking, oceanographic moorings, and remote sensing technologies. Recent technological advances in electronic archival tags and pop-up tags and their role in upcoming research efforts were discussed in considerable detail. Data from a recent National Marine Fisheries Service (NMFS) archival tag returned after a 3-month deployment on a bigeye tuna in Hawaii waters were presented by researchers from the Honolulu Laboratory; they also described how these data were used to make geoposition estimates based on crepuscular diving behavior without the use of sun-based navigation. This technique will be very useful for deep-swimming species such as bigeye tuna and swordfish, which may seldom experience tag-measurable light levels at sunrise or sunset.

The meeting concluded with unanimous agreement to conduct a coordinated international research effort on bigeye tunas. Representatives will continue working on research plan details via correspondence. A follow-on workshop is being planned to finalize the prospectus.

Highlights of the 1998 Tuna Conference – More than 100 persons participated in the 49th Annual Tuna Conference at Lake Arrowhead, California, May 18–21, 1998. The conference was chaired by Chris Boggs, head of the Honolulu Laboratory's Fish Biology and Ecology Investigation. Conference proceedings, including 58 abstracts of talks and poster presentations, were distributed at the meeting. The theme of the 1998 conference was "Changing Management Paradigms," and a highlight of the meeting was a panel discussion on

"Meeting Magnuson-Stevens Fishery Conservation and Management Act Mandates in Tuna Fisheries." Other special sessions included a special celebration of the Honolulu Laboratory's 50th anniversary and a mini-symposium with presentations on the population genetics of tunas and billfishes.

The 50 years of tuna research celebrated at the meeting represented a historical milestone and largely encompassed the history of tuna fishery biology and oceanography in the Pacific. The opportunity for scientific feedback on the Magnuson Act mandates and the opportunity to exchange views with NMFS headquarters staff were very useful. The genetics session made a strong impression on a largely skeptical audience that real progress is finally being made in defining billfish stock structure for management purposes.

ISC Committee Meetings – Meetings of the Interim Scientific Committee for Tuna and Tuna-like Species in the North Pacific (ISC), including the Swordfish and Statistics Working Groups and Plenary Committee, were held in Honolulu during January 15–23, 1999. The Honolulu Laboratory hosted and handled all the logistics for the meetings. Approximately 50 representatives from Japan, Taiwan, Peoples Republic of China, Mexico, Canada, and the United States, as well as the Inter-American Tropical Tuna Commission (IATTC), the Secretariat of the Pacific Community, and the North Pacific Marine Science Organization, participated in the meetings. Science Director Michael Tillman was selected to serve as the chairman of the Plenary Committee meeting. Substantial progress and accomplishments were made at the various ISC meetings, including plans for international cooperation and collaboration related to Pacific swordfish and fisheries statistics and related data for use in fisheries research and assessments by ISC working groups. In addition, a Pacific marlins working group was established, which will be under the leadership of the United States. A reception honoring the ISC delegates and commemorating the Honolulu Laboratory's 50th anniversary was held the evening of January 20.

Oracle Database Development – The Honolulu Laboratory is converting from a long- established flat file archival system to a modern online, relational database using Oracle database software. The goal is to improve access to data and database summaries, not only for laboratory researchers but also for the Western Pacific Regional Fishery Management Council and other users.

The PFRD at the La Jolla Laboratory was the first to develop an enterprise model, and a development team at the Honolulu Laboratory later joined that effort. The design of the database model was heavily influenced by the Oracle Corporation contractors, first in La Jolla and then later in Honolulu. These designers followed, as is common in business, the approach of modeling the data collection and standard analyses and report preparation activities, but they primarily used pelagic data sets in the design phase. After some minor revisions, the Honolulu Laboratory Oracle development team was able to get this model working and to enter data into it. The PFRD Oracle database is operational and receiving data.

Web Development – Internet sites have been implemented for the Honolulu Laboratory (http://www.nmfs.hawaii.edu), the Western Pacific Information Network (http://wpacfin.nmfs.hawaii.edu), and a NOAA ship *Townsend Cromwell* student page (http://atsea.nmfs.hawaii.edu).

The Honolulu Laboratory site provides information about the laboratory and the type of research conducted. More informative pages about specific research projects and various data products are under development. The Western Pacific Information Network (WPACFIN) site has separate pages for Hawaii, American Samoa, Guam, and the Northern Mariana Islands. Annual summary fishery statistics are provided on each of these pages. The

Townsend Cromwell student site provides information about ongoing research cruises and the schedule of future cruises. The site provides an interactive page for students to have their questions answered about activities and research being conducted on this research vessel.

Geographical Information System Development—The Honolulu Laboratory has the capability of conducting analyses using geographical information system (GIS) software. Much of the initial work has been directed toward building a library of coastline, bathymetric, and other baseline data for the Hawaiian Islands, American Samoa, Guam, the Northern Mariana Islands, and U.S. territories. In support of essential fish habitat work, GIS data files have been created with biological data (species, size, sex, maturity) for lobsters and bottomfishes primarily from the Northwestern Hawaiian Islands. Procedures have also been developed for routinely producing maps of the distribution of catches and effort by the Hawaii-based longline fishery linking to data in the laboratory's Oracle database.

V. EASTERN TROPICAL PACIFIC TUNA FISHERIES

Dolphin-Safe Research Program Activities – During the past year the Marine Mammal Division's Dolphin-Safe Research Program at the La Jolla Laboratory completed several investigations focused on the development of acoustic and optical detection devices capable of detecting and tracking large yellowfin tuna at ranges currently not possible. These airborne optical and ship-towed acoustic devices may provide tuna fishermen in the eastern tropical Pacific Ocean (ETP) an alternative to locating tuna associated with dolphins. Program staff hope to eliminate the current practice of "dolphin fishing" in the ETP, during which dolphins and the associated large yellowfin tuna are located, chased, and encircled with a purse seine net in order to capture the tuna. By concentrating on large yellowfin tuna not associated with dolphins, these devices could provide a "dolphin-safe" fishing method that would both eliminate dolphin mortality and the bycatch of smaller tunas, billfish, sharks, and other species associated with existing dolphin-safe fishing on flotsam and schools of yellowfin tuna.

Final reports were published for two acoustic detection systems (Denny et al., 1998; Rees, 1998). Both systems appear capable of detecting 15-ton schools of yellowfin tuna at nominal distances of 10 to 20 km in the offshore, mixed layer of the ETP and in some areas at distances out to 50 km. Both systems use a high-decibel sound source (195 dB re 1 µ Pa), to obtain maximum detection range. Lower sound levels will reduce detection distance but not degrade to the detection capability of the units.

Program staff published a report describing swimbladder volumes obtained from large yellowfin tuna (Schaefer and Oliver, 1998). Much of the acoustic target return from fish results from the swimbladder. The optimal frequency is dependent upon the swimbladder volume, and for large yellowfin tuna, the optimal frequency was based on a guess of swimbladder volume.

A report on the potential impacts of high sound levels on marine mammals associated with the acoustic detection systems also was published (Ketten, 1998). The report provides a description of currently available data on marine mammal hearing and ear anatomy, a discussion of the methods used to obtain these data, the caveats entailed in cross species/cross modality comparisons, and a discussion of the forms and mechanisms of acoustic trauma in mammals in general. Program staff are participating in experiments to obtain direct measurements of blast and acoustic trauma effects on marine mammals in conjunction with several government and research institutions.

Field experiments were completed on an airborne optical detection demonstration project funded under the Saltonstall-Kennedy

Grant Program as a technology to reduce dolphin bycatch. Arete Associates Inc. for the Office of Naval Research developed the airborne streak tube imaging lidar (STIL) system. Airborne experiments to demonstrate the capability of STIL to measure the 3-D distribution of fish schools and, for larger fish species, to obtain counts of individual fish were conducted during January 1997 at the Scripps Institution of Oceanography deep tank, during April 1997 for southern bluefin tuna off Australia in cooperation with CSIRO, around the Hawaiian Islands in September 1997 for yellowfin tuna, and during July 1998 off Cape Cod for giant bluefin tuna. The effort will conclude with a technical summary and recommendations for a cost-effective commercial sensor configuration.

Program investigations also resulted in a published report addressing potential impacts of the laser energy used in airborne lidar detection systems on marine mammals (Zorn et al., 1998). Based upon an analysis of species-specific lens diameter, focal length, and visual acuity, and commonly used laser energies, sensitivity ratios were calculated for several marine mammals. Comparison of these ratios with human eye-safety laser standards indicates the airborne lidar detection systems that the Dolphin-Safe Research Program has investigated do not pose a hazard to the marine mammals examined. Specimens are being obtained to expand the number of marine species examined for laser safety determination.

International Dolphin Conservation Program Act (IDCPA) Research - IDCPA research activities during the past year included (1) completion of a research survey to estimate current abundance of dolphins stocks affected by the tuna purse seine fishery in the ETP; (2) completion of new estimates of dolphin abundance for the depleted dolphin stocks; (3) development of a decision analysis framework and population assessment modeling to quantify the likelihood that depleted stocks of ETP dolphins are or are not recovering as expected since the dramatic decrease in reported mortality beginning in 1992; (4) completion of a review of dolphin stress-related literature; (5) completion of necropsy program development and training; (6) completion of a Congressional report on the results of the abundance survey and stress studies; and (7) preliminary investigation of molecular genetics techniques to identify molecular-level effects of fishery-induced stress and to determine cow/calf relatedness in mortalities from single sets.

The dolphin abundance survey also included a variety of ancillary research projects to aid in interpreting the new abundance estimates, in particular oceanographic and other biota data. The ancillary research was designed to help determine whether environmental conditions might have changed substantially since previous abundance estimates were produced, in order to better evaluate consistency between previous and current estimates of abundance.

The population analysis model included estimating abundance trajectories from the early 1970s through 1998, utilizing abundance estimates resulting from NMFS research cruises in combination with estimates of trends in abundance derived by the IATTC from tuna vessel data.

The review of stress-related literature focused on research relevant to determining whether dolphins in the ETP may be significantly affected by fishery-related stress from the chase, capture, and release procedures used by the fishery.

The necropsy program, designed to collect fresh samples from dolphins killed during routine fishing operations, was completed to the stage of training several potential necropsy technicians and assembling full necropsy kits, including detailed instruction manuals and videos in Spanish. No samples have been collected, although Mexico has agreed to participate in the necropsy program by allowing technicians on tuna seiners as space becomes available.

The first of the two molecular genetics projects is being focused on determining whether dolphin skin cells can be used to assess stress levels. This would be useful because there is a large historical data bank of skin samples from the fishery, and additional samples can be collected relatively simply by biopsy dart from both fishery-affected (stressed) and fishery-unaffected (non-stressed) dolphins. The second project is directed to estimating the potential effect of tuna fishery operations on cow/calf separation and differential mortality. Results from these studies will not be available until 2002.

The report to Congress contains details of the dolphin abundance survey and stress studies summarized above. Based on this report and other relevant information, the NMFS made an initial finding required by the IDCPA that there is insufficient evidence that chase and encirclement by the tuna purse seine fishery is having a significant adverse impact on depleted dolphin stocks (eastern spinner, northeastern offshore spotted, and coastal spotted) in the ETP. As a result of this finding, which was announced April 29, 1999, the United States will change its dolphin-safe tuna labeling standard and allow the use of the dolphin-safe label on tuna caught in the presence of dolphins if no dolphins were killed or seriously injured.

The Congressional report and other IDCPA research results are available on the SWFSC's Web site (http://swfsc.ucsd.edu/IDCPA/IDCPAfront.html). Information about the NMFS decision can be found on the Internet at http://www.nmfs.gov/prot_res/main/tunadolphin. html.

VI. SHARK RESEARCH

Thresher Shark Tagging Experiment Completed - PFRD researchers aboard the NOAA ship *David Starr Jordan* conducted a tagging experiment on common thresher sharks (*Alopias vulpinus*) in coastal waters off southern California June 27– July 14, 1998. The purpose of the study was to develop methods to capture thresher sharks alive with longline gear, immobilize them, attach tags, release the sharks, and track them with ultrasonic acoustic telemetry. The work was necessary because previous attempts to catch thresher sharks alive using conventional longline gear resulted in nearly 100% mortality of captured sharks.

Thirty longline sets were made during the cruise using modified hook type and size, bait size, length of set, and a newly constructed shark immobilizing cradle. A total of 41 thresher sharks, 41 shortfin mako sharks, 1 dusky shark, and 16 blue sharks were caught. Twelve blue sharks, 26 shortfin mako sharks, and 33 thresher sharks were tagged and released for population and migration studies. Five of the thresher sharks were tagged with sonic tags, and 3 of them were tracked for 24 hours or longer; the remaining 2 sharks were tracked for only 2 hours because of equipment problems. Each of the thresher sharks tracked appeared to behave normally, and it was concluded that there was no short-term mortality associated with their capture and release. Blood and tissue samples also were collected from some of the captured sharks for later analysis.

The new methodology developed on this cruise is a breakthrough that will allow advanced research on the distribution, behavior, and stock structure of thresher sharks using satellite and archival tags.

Pacific Shark Manuscript Published – The manuscript "Rebound potentials of 26 species of Pacific sharks" (Smith et al., 1998) was published in a special shark fisheries management and biology issue of the Australian journal *Marine and Freshwater Research*. The paper is an extension of a previous paper (Au and Smith, 1997) describing a modified demographic method for estimating productivity, applied to the leopard shark (*Triakis semifasciata)*. The method estimates the rate of population increase or rebound potential of a species, does not require large data sets, and

incorporates a density-dependent population response. Another manuscript now being prepared will examine the method at greater depth. To be discussed are sensitivity of productivity estimates to life-history input parameters, including level of fishing mortality suffered, the relationship of production, yield per recruit, and this demographic model, some protective biological reference points that can be derived, and a comparison of shark productivities with some pelagic teleosts of commercial importance.

VII. BILLFISH INVESTIGATIONS

The Center's Billfish Research Program provides information for the conservation and rational management of billfish resources in the Pacific Ocean. Program staff are committed to providing sound fishery data analysis, fishery management information, and advice for U.S. fishery management councils and international agencies.

The *Billfish Newsletter* (available on the Internet at http://swfsc.ucsd.edu/billfish.html) is an annual publication that describes the primary components of the Billfish Research Program: the International Billfish Angling Survey and the Billfish Tagging Program. The survey and the tagging program provide essential information for exploring management concerns pertaining to the recreational billfish angling community. The Angler Survey provides catch and angler effort information, while the Billfish Tagging Program provides much needed data on the biology, distribution, and migration rates of these far-ranging species. Both investigations rely on the continuing cooperation of billfish anglers, sportfishing clubs, commercial fishers, and agencies affiliated with the SWFSC.

Results of the 1998 Billfish Angler Survey – Since 1969 the International Billfish Angler Survey has provided information on recreational anglers' billfish catch and fishing effort by location. Long-term trends in angler catch rates by specific area are important in understanding the impact of fisheries on billfish resources.

In 1998, 570 billfish anglers reported catching 3,519 billfish during 8,159 fishing days. The overall CPUE (measured in catch per day fished) for 1998 was 0.42 billfish per angler-day, compared to 0.44 billfish per angler-day for 1997. The total number of angler-days reported for 1998 decreased nearly 30% from the previous year. The 1998 overall catch rate (0.42) is slightly lower than the prior 4-year average of 0.47 (1994 to 1997). The highest reported catch rate (0.57 billfish per angler-day) occurred during the first years of this survey (1969 to 1971). The lowest catch rates occurred in the mid-1970s, averaging about 0.34 billfish per angler-day.

In 1998, a high catch rate for striped marlin (0.41) was reported at the southern tip of Baja California, Mexico; the catch rate for all of Mexico was 0.33. High catch rates were reported for blue marlin in Hawaii (0.29), Solomon Islands (0.21), Mauritius (0.29), Kiribati (0.23), and Tahiti (0.36). Australia (0.23) and Panama (0.13) reported the highest catch rates for black marlin. Excellent fishing for sailfish was reported from Mazatlan, Mexico, southward through southern Mexico (0.61), Guatemala (3.45), Costa Rica (1.54), and Panama (0.83). Anglers in the Indian Ocean reported 4.05 sailfish per angler-day, with excellent fishing in the Persian Gulf (United Arab Emirates, 5.81) and Kenya (0.80).

Billfish Tagging Program Results – The Billfish Tagging Program utilizes release and recapture data from tagged billfish to determine movement, distribution, and growth patterns of billfish. The program encourages the participation and cooperation of recreational anglers, sportfishing organizations, and commercial fishers. Since the program's inception in 1963, more than 44,400 billfish have been tagged and released throughout the Pacific and Indian Oceans. As a result, the program's tagging priorities occasionally change to emphasize current needs. The current emphasis is the tagging of swordfish, striped marlin, blue

marlin, and black marlin from all areas of the Pacific and Indian Oceans and the tagging of sailfish from selected areas only. Tagging of other species such as tunas, wahoo, and sharks is outside the scope of current studies.

The billfish tagging report cards received in 1998 indicate a total of 618 billfish were tagged and released by 368 anglers and 182 fishing captains. This is 28% fewer tags released than in 1997. The number of striped marlin tagged off southern California remained about the same at 99; the 4-year average is 98. Far fewer tags were released in Hawaiian waters than in past years: only 220 billfish were tagged, compared to an average of 540 in recent years. Tagging off Baja California Sur, Mexico, also remained similar to past levels. Twelve recaptures were reported in 1998: 2 striped marlin, 5 sailfish, 1 shortfin mako shark, 2 common thresher sharks, 1 wahoo, and 1 unidentified billfish.

Other Tagging Program Activities – During the year the SWFSC and the Billfish Foundation continued a joint analysis of their tagging data for the Pacific region. The SWFSC also furnished tagging supplies to tournament anglers, including participants in the first AFTCO Pacific Tag-Flag Tournament. The tournament promotes the conservation of highly migratory species through tag and release programs and is supported by numerous organizations, including the International Game Fishing Association, the Billfish Foundation, the National Coalition for Marine Conservation, the American Sportfishing Organization, and many popular sportfishing publications. The SWFSC supplied tagging supplies to participating anglers and provided AFTCO officials with the results of our 1998 billfish tag releases.

Also, the design of billfish tags changed this year, and the Center began supplying the new highly migratory (HM) tags and new applicator pins. Studies show the HM series tags with nylon anchor tips have superior tag retention characteristics and result in fewer wound infections.

VIII. OTHER ACTIVITIES

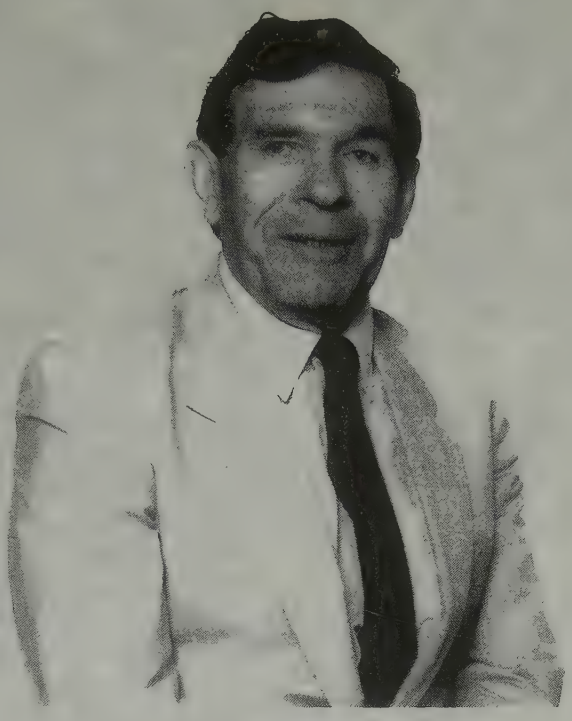
Iz Barrett to be Honored at 1999 Tuna Conference – Dr. Izadore Barrett, former Director of Science and Research at the SWFSC, will be honored at this year's annual Tuna Conference for his role in promoting and fostering the conference and advancements in tuna-related research.

Barrett's fisheries career nearly spanned the 50-year history of the conference itself. Born in Vancouver, British Columbia, he received degrees at the University of British Columbia in Vancouver—a B.A. degree in zoology in 1947 and an M.A. degree in zoology and marine fisheries in 1949. He pursued postgraduate studies in experimental biology at the University of Toronto, Canada, and received his Ph.D. degree in public administration of fisheries from the University of Washington at Seattle; his Ph.D. dissertation was entitled "Development of a management regime for the eastern Pacific tuna fishery."

He began his career as biologist with the British Columbia Game Commission in Vancouver in 1952. He then moved on to serve as chief of the IATTC's laboratory in Panama from 1956 to 1959 and then as senior scientist for the IATTC at La Jolla, California, from 1959 to 1967. From 1967 to 1969, he served as chief biologist of the United Nations Development Program's Fisheries Development Project at Santiago, Chile, and from 1969 to 1970 as the United Nations Food and Agriculture Organization's fisheries advisor to the government of Chile.

In 1970, he began his career with the NMFS as deputy director of the SWFSC in La Jolla, California. In 1977, he was promoted to science and research director of the Center, serving in that position until his retirement October 1, 1992. Under his direction the SWFSC became recognized as a leader in the field of tuna and tuna-related research, tuna-dolphin interaction research, and protected species management.

In 1976, as acting director, he reorganized the Center to meet the needs of the Department of Commerce, whose responsibilities had just expanded under the Magnuson Fishery Conservation and Management Act, the Marine Mammal Protection Act, and the Endangered Species Act. It was his idea to establish multidisciplinary teams at the Center consisting of biologists, economists, and other experts to address resource problems from various perspectives. Among other advances, he pushed strongly (and successfully) for new and better technologies to solve fisheries and marine mammal problems, for a reliable central and western Pacific fisheries database (WPACFIN), for more effective strategic planning for both Center and NMFS programs, and for new, more efficient, and reliable sea survey designs. The strategic planning method, first used for the albacore program in 1983 and later for other programs at the Center, enabled the Commerce Department to develop long-term research plans that take into account the diverse needs of all constituents and stakeholders with interests in the resource under study.



Dr. Izadore Barrett

Barrett took stock of the fisheries and charted a new direction for tuna research at the Center, to better provide management advice on tunas and billfishes to U.S. delegations to international tuna management commissions. He had his staff prepare a status of stocks report covering 5 major tuna and billfish stocks in the Pacific and Indian Oceans and an overview of worldwide tuna production and trade. In the research he directed, he recognized the importance of environmental variables, combining research at sea with laboratory work to determine how tuna responded physiologically to their oceanic environment, and promoted the use of satellite imagery and other oceanographic data collection techniques to better understand the relationship between tuna and billfish and the environment. The fishery for albacore in the South Pacific was developed with considerable help from Barrett and his staff. In 1987, he standardized publication of the *Tuna Newsletter* to 4 times a year and expanded its scope to include tuna research results beyond the Center and events in the tuna industry worldwide, including a regular column featuring the most recent statistics of the U.S. tuna industry. This newsletter provided periodic summaries of progress on tuna research and international tuna and trade to researchers, industry, and fisheries commissions around the world for 25 years. The *Tuna Newsletter* was recently discontinued, but it is important to remember that in the pre-Internet decades it served as a valuable one-stop source of information on recent developments in tuna research and trade worldwide.

Barrett was also an exceptional leader and developer of fishery-marine mammal interactions research. In response to Congressional needs in the late 1970s for information on dolphin mortality in the tuna fishery, Barrett reorganized the Center's tuna/dolphin research program in 1980 to address not only the conflicts between the fishery and marine mammals, but also the status and incidental kills of marine mammals, improved fishing gear, and marine mammal rescue methods. He organized a committee of survey design experts, then developed the at-sea monitoring program to survey abundance of dolphins at risk in the tuna fishery—methods that set the survey standards in use today.

Iz Barrett was instrumental in the growth, expansion, and support of the annual Tuna Conference, especially in the latter half of its history. Soon after his appointment as Center director in 1977, he approached Gary Sakagawa and others on his staff because he was concerned about the fall-off in attendance at the conference in the mid-1970s. He then proceeded to commit himself to boosting attendance at the conference and to broadening its scope. Iz encouraged his staff to attend each meeting and put it high on his own list of meetings to attend. He did much toward expanding the scope of the conference by encouraging members of the industry, academia, and other constituents and research groups to attend, including researchers beyond U.S. and tropical Pacific waters. He invited researchers from the U.S. east coast, Europe, Latin America, and the Pacific Rim to join with those who had historically attended from California and Hawaii. He provided funds to bring in special speakers from other regions and countries, and also assumed an ample share of local transportation costs to and from the conference to make it that much easier for people to attend. He also supported efforts to make the conference more attractive by improving some of the social niceties of the meetings, making the conference much more enjoyable as well as informative—for example, popular events such as the sushi party and fish barbeque, which required special donations from the industry. Iz also greatly expanded the SWFSC's *Director's Report to the Tuna Conference*, including a personal introductory statement that summed up his vision and goals for the Center on tuna-related research and reviewed emerging research within the context of developments in tuna and billfish fisheries around the world. In addition to distribution at each meeting, Iz made sure copies of the report were sent annually to a large mailing list of industry members to ensure they were kept informed, especially those who could not attend the conference.

Dr. Iz Barrett, along with IATTC Director Jim Joseph who will also be honored at this year's conference, did much to make the conference as diverse and interesting as it is today. He helped expand its depth and scope so that now we have presentations on subjects ranging from ETP ecosystem modeling and stock assessment, Australian and Reunion Island swordfish fisheries, transpacific tracking of bluefin tuna, genetic variation in Atlantic blue marlin, effects of environmental changes (seasonal and decadal) on movement and abundance of Pacific albacore and loggerhead turtles, the Indian Ocean tropical tuna fishery, Atlantic bluefin tuna management, Maldivian skipjack tuna age and growth, and Coral Sea bigeye tuna tagging. For these reasons, he well deserves to be honored at this anniversary meeting as one of the instrumental mentors and promoters of the Tuna Conference, and an important player in its history.

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Table 1. Catch and effort data for purse seiners submitting logbooks to the Seychelles Fishing Authority by August 20, 1998.

MONTH	VESSELS FISHING	DAYS FISHED	CATCH		
			YELLOWFIN	SKIPJACK	ALL TUNAS
1997					
JAN	48	1,263	8,782	7,922	18,374
FEB	50	1,182	9,901	13,516	26,450
MAR	52	1,349	7,921	15,550	26,309
APR	51	1,203	4,322	16,925	24,004
MAY	52	1,281	3,742	9,514	15,021
JUN	51	1,207	6,558	3,299	12,183
JUL	52	1,337	8,574	5,553	15,567
AUG	53	1,404	4,970	17,228	24,129
SEP	54	1,353	3,548	24,539	30,822
OCT	53	1,353	3,813	28,058	34,870
NOV	52	1,295	4,776	18,055	25,028
DEC	54	1,346	4,459	11,190	18,274
TOTAL		15,573	71,366	171,349	271,031
1998					
JAN	52	1,322	4,776	12,980	21,322
FEB	50	1,242	1,617	15,078	19,381
MAR	50	1,322	2,975	22,309	27,514
APR	50	1,266	3,546	17,034	22,073
MAY	50	1,165	3,354	8,185	13,142
JUN	46	1,076	16,480	6,316	24,936
JUL					
AUG					
SEP					
OCT					
NOV					
DEC					
TOTAL		7,393	32,748	81,902	128,368

Table 2. Summary of Hawaii-based domestic longline activity over the past 7 years. Data for this table are compiled from Federal logbooks filed by domestic longline fishermen landing their catch in Hawaii and from NMFS shoreside monitoring. DOL = date of landing; DOH = date of haul.

Total	1992	1993	1994	1995	1996	1997	1998
			All Trips				
Vessels (DOL)	123	122	125	110	103	105	115
Trips (DOL)	1,265	1,192	1,106	1,125	1,100	1,122	1,180
Sets (DOH)	10,704	11,351	1,231	11,708	14,155	11,832	12,491
Hooks (1,000s)	10,947	12,138	11,319	14,155	14,141	15,548	17,352
Light sticks (1,000s)	3,015	3,012	1,964	1,328	903	879	1,223
			Swordfish Trips				
Vessels (DOL)	66	79	74	44	33	26	32
Trips (DOL)	277	319	310	136	92	78	88
Sets (DOH)	3,159	3,717	3,607	1,846	1,146	1,076	1,223
Hooks (1,000s)	2,516	3,208	3,080	1,465	913	841	1,019
Light sticks (1,000s)	1,908	2,135	1,679	721	301	293	519
			Mixed Trips				
Vessels (DOL)	72	59	51	49	51	44	52
Trips (DOL)	530	331	228	307	351	301	312
Sets (DOH)	3,800	2,960	1,600	2,918	3,639	3,216	3,395
Hooks (1,000s)	3,359	2,570	1,340	2,504	3,039	2,512	2,848
Light sticks (1,000s)	1,069	847	242	538	552	546	654
			Tuna Trips				
Vessels (DOL)	55	61	83	78	76	83	92
Trips (DOL)	458	542	568	682	657	743	780
Sets (DOH)	3,745	4,674	4,901	6,944	6,647	7,500	7,873
Hooks (1,000s)	5,073	6,359	6,843	10,186	10,196	12,104	13,484
Light sticks (1,000s)	38	31	43	69	50	40	49

Table 3. Total number of fish caught, Hawaii-based domestic longline fishery.

Species	1992	1993	1994	1995	1996	1997	1998
Blue marlin	4,516	5,124	4,677	8,873	6,685	8,253	5,259
Spearfish	3,085	3,677	3,942	9,995	6,447	7,307	9,926
Striped marlin	16,049	18,210	11,292	22,715	15,789	12,627	14,340
Swordfish	74,314	79,554	43,345	37,622	38,225	37,307	43,759
Other billfish	2,583	2,004	1,175	1,900	1,359	1,708	1,577
Blue shark	89,292	150,216	110,187	95,312	96,224	79,978	91,000
Mako shark	1,008	1,314	1,075	1,799	1,146	1,166	1,384
Thresher shark	1,608	853	1,460	1,828	1,887	2,332	3,845
Other sharks	2,989	2,225	1,934	2,834	1,745	2,326	3,465
Albacore	19,813	30,460	31,129	46,100	57,329	71,079	48,811
Bigeye	43,902	54,803	48,102	60,680	63,575	79,687	98,688
Bluefin	108	478	218	228	264	242	233
Skipjack	3,391	4,878	6,802	13,496	5,395	12,061	8,795
Yellowfin	7,879	16,062	13,516	23,798	17,586	29,031	21,702
Other tunas	3,499	5,356	7,020	13,919	5,659	12,303	nes
Mahimahi	56,684	26,018	33,017	60,748	23,311	49,313	21,894
Moonfish	3,293	4,515	5,090	6,416	7,315	8,250	9,184
Oilfish			108	1,605	1,189	1,748	2,661
Pomfrets			1,186	6,277	8,299	10,423	14,771
Wahoo (Ono)	2,448	4,442	2,513	6,764	4,461	8,309	8,277

Table 4. Average whole weight size of landed fish for the major species from the Hawaii-based domestic longline fishery. Weights are derived from NMFS shoreside market monitoring. (Average weights not available for 1998.)

Species	1992	1993	1994	1995	1996	1997	1998
Blue marlin	175	157	171	157	154	134	
Spearfish	34	34	33	33	31	31	
Striped marlin	66	64	64	58	58	66	
Swordfish	178	172	163	171	157	163	
Blue shark	100	100	100	100	100	100	
Mako shark	144	147	153	176	177	161	
Thresher shark	176	199	164	175	156	160	
Albacore	45	44	41	50	53	54	
Bigeye	77	88	81	79	64	71	
Bluefin	192	202	200	269	223	239	
Skipjack	17	17	18	18	17	20	
Yellowfin	99	92	97	95	80	89	
Mahimahi	11	13	12	10	17	13	
Moonfish	98	101	103	101	105	103	
Wahoo (Ono)	35	33	34	31	31	30	

Table 5. Trends in ex-vessel revenue for the major species. Revenues are estimated from the landed weights (logbook number kept * average weight per fish) * the average market price per pound (whole weight). Prices for 1998 are not available yet, so these tables use 1997 average prices.

Species	1992	1993	1994	1995	1996	1997	1998
Swordfish	24,192	26,593	17,035	14,170	13,226	14,910	16,112
Other billfish	2,508	1,808	2,400	2,593	2,467	2,449	2,139
Sharks	181	473	502	952	1,063	1,252	1,556
Albacore	868	1,210	1,188	1,976	3,328	4,608	3,072
Bigeye	11,781	16,779	15,561	18,354	15,440	21,230	25,090
Bluefin	243	1,329	636	852	704	773	699
Skipjack	118	88	67	148	91	182	182
Yellowfin	2,328	3,836	3,705	5,940	4,242	7,575	5,454
Mahimahi	840	408	556	864	776	970	582
Moonfish	330	430	550	660	880	880	990
Wahoo (Ono)	246	194	264	336	213	426	320
Total	45,547	56,371	43,920	49,610	43,882	58,261	57,921

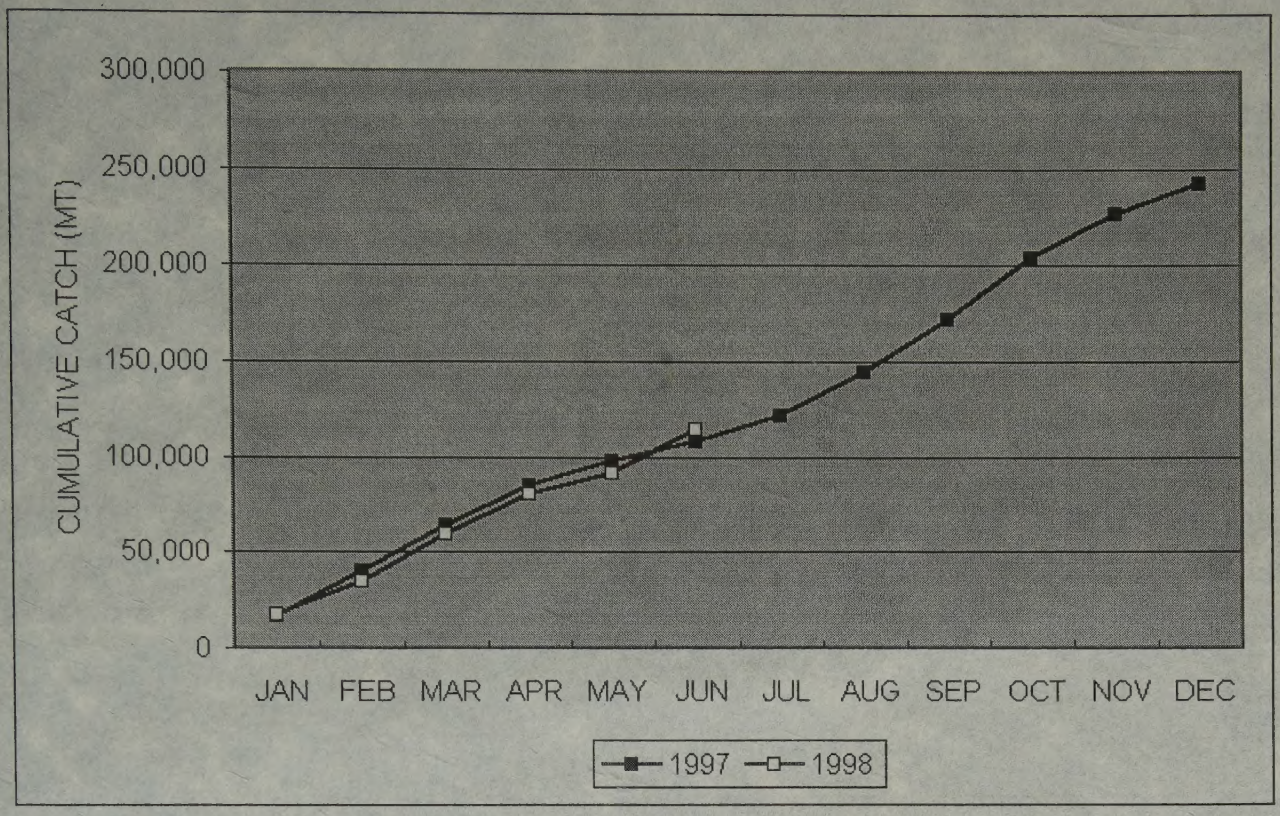

Figure 1. Cumulative catches (metric tons) of yellowfin and skipjack tuna by purse seiners in the western Indian Ocean, 1997-98.

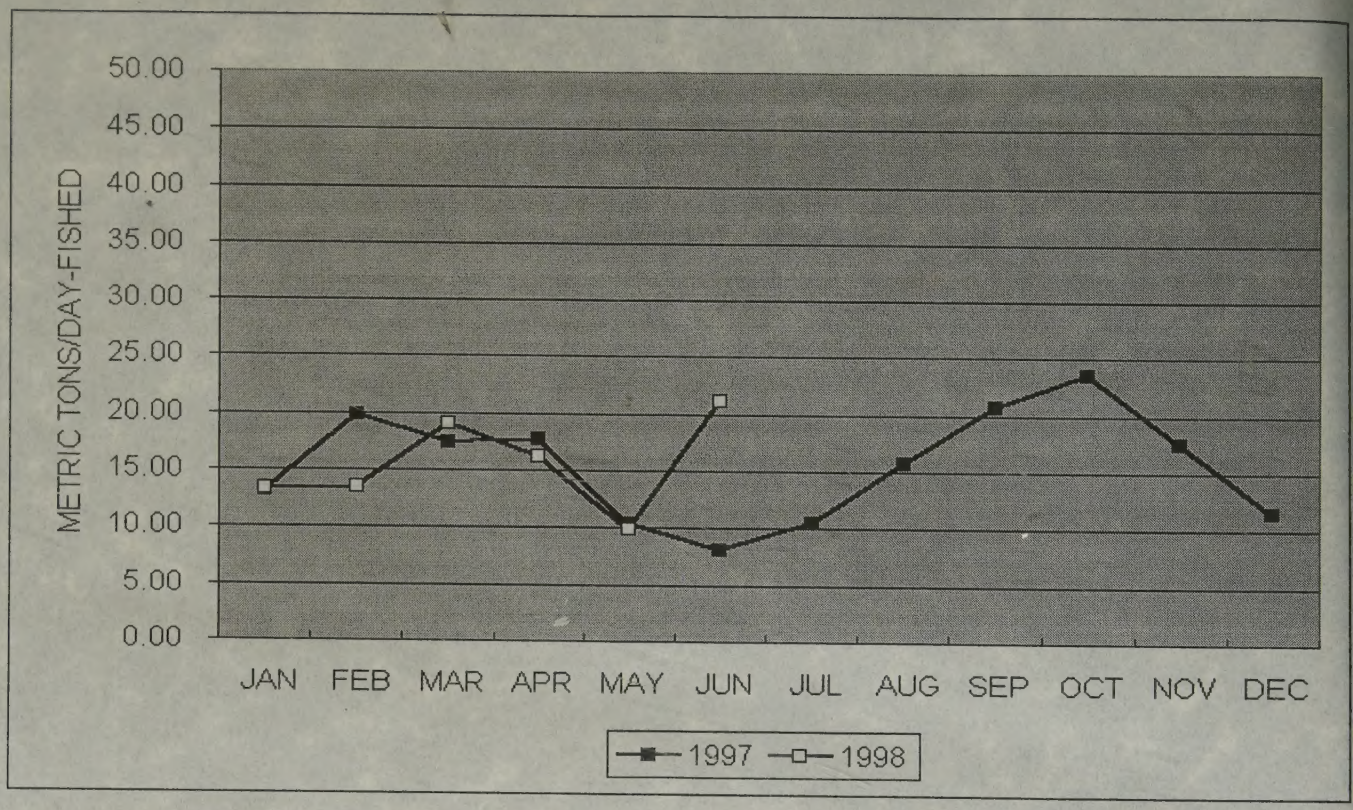

Figure 2. Catch rates (metric tons/day fished) of skipjack and yellowfin tunas for purse seiners fishing in the western Indian Ocean, 1997-98.